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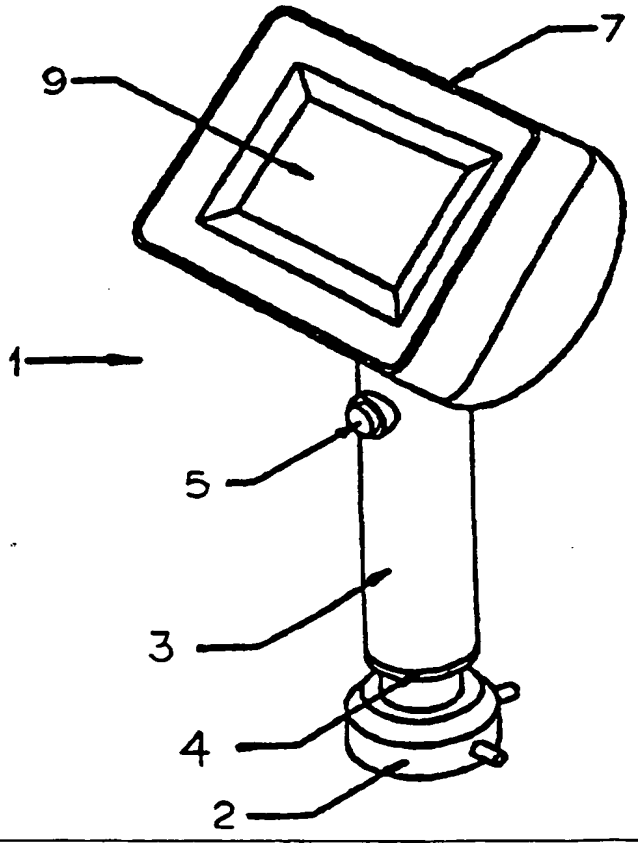
(54) Title: HAND-HELD IMAGING APPARATUS FOR USE WITH ENDOSCOPES

(57) Abstract

An apparatus particularly configured for coupling to the proximal end of a medical endoscope for presenting a video image of the target site at the distal end of the endoscope. The apparatus is comprised of (1) a camera housing containing a solid state electronic imaging sensor, (2) a video monitor, and (3) an endoscope coupler, wherein the camera housing contains no motor driven parts and the housing exterior is dimensioned and shaped so that it can be readily held in a user's hand. The video monitor is configured for detachable attachment to the camera housing via an electromechanical connector which affords both an electrical interconnection and an adjustable substantially rigid structural attachment.



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TITLE : **HAND HELD IMAGING APPARATUS FOR USE WITH ENDOSCOPES**

BACKGROUND OF THE INVENTION

This invention relates to a hand held apparatus particularly configured for attachment to the proximal end of a medical endoscope for producing a video image representative of a target site at the distal end of the endoscope.

Traditionally, when using a medical endoscope, a physician places his eye directly against an eyepiece at the endoscope's proximal end. The typical endoscope contains a lens at its distal end for gathering an image of the target site and optically coupling the image via optical fibers to the endoscope eyepiece. A high intensity light source is generally provided for illuminating the target site to enhance image gathering.

In recent years, video monitoring systems for medical applications have been made available which utilize an electronic camera head for capturing the image at the endoscope eyepiece. The captured image is then relayed via electronic cables to a cart mounted subsystem which converts the image to a standard NTSC or PAL video format for driving a CRT (cathode ray tube) monitor. Such systems are marketed commercially by various companies and are typically comprised of a large mobile cart on wheels which carries camera control electronics, a CRT monitor, and a high intensity light source. As a consequence, they are typically cumbersome, expensive, and occupy a lot of valuable space.

Additionally, it is believed that commercially available camcorders have been

used in conjunction with flexible boroscopes for industrial applications to provide a user with a convenient video image remote from a target site at the scope distal end. Although the size and weight of available camcorders have diminished over the years, they are still too large and heavy, attributable in part to their motor driven feed systems, to be conveniently used for many medical procedures.

SUMMARY OF THE INVENTION

The present invention is directed to an apparatus particularly configured for coupling to the proximal end of a medical endoscope for presenting a video image of the target site at the distal end of the endoscope.

Apparatus in accordance with the invention is comprised of (1) a camera housing containing a solid state electronic imaging sensor, (2) a video monitor, and (3) an endoscope coupler, wherein the camera housing contains no motor driven parts and the housing exterior is dimensioned and shaped so that it can be readily held in a user's hand.

In accordance with a preferred embodiment, the video monitor is configured for detachable attachment to the camera housing via an electromechanical connector which affords both an electrical interconnection and an adjustable substantially rigid structural attachment.

In the preferred embodiment, the camera housing defines an optical input port and a video output port. A mount is provided on the housing for accommodating the endoscope coupler which is configured for detachable rigid attachment to the endoscope eyepiece. When attached, the endoscope eyepiece

can focus an image, via the coupler and through the input port, onto an imaging sensor in the camera housing. The imaging sensor preferably comprises an array of charge coupled devices (CCD) mounted at the focal plane of the coupler lens system.

The video output port is preferably formed by one half of an electromechanical connector configured for detachable attachment to a mating connector carried by the video monitor, e.g. a liquid crystal display (LCD) screen. In a preferred embodiment, the camera housing output port comprises a female connector (e.g., RJ45) and the video monitor carries a mating male connector. The male and female connectors are constructed so that when engaged, they provide both an electrical interconnection and a substantially rigid structural attachment.

As a consequence of the rigid attachments between the camera housing, the video monitor, and the endoscope coupler and eyepiece, a physician is able to hold the camera housing in one hand and position the endoscope for convenient manipulation and the video monitor for comfortable viewing.

In accordance with a significant feature of the preferred embodiment, the male connector is connected by a stiff swivel mount to the video monitor for enabling a physician to adjustably position the monitor relative to the hand held camera housing to enhance the physician's flexibility of use and viewing comfort.

In accordance with a further feature of the preferred embodiment, a flexible electric cable can be interposed between the aforementioned male and female connectors to enable the video monitor to be physically displaced from the camera housing. This feature enables a physician to selectively mount the monitor in a

variety of manners such as on a table, on an I.V. pole, in a sternum or head mount harness, etc.

In accordance with a still further feature of the preferred embodiment, a flexible power cable is provided for connecting the camera housing to a power source. The cable preferably includes a video signal line for driving a remote video monitor or video recorder.

Embodiments of the invention can be advantageously employed in many different applications including, for example, the endoscopically directed placement of endotracheal tubes. This procedure involves insertion of the endotracheal tube through the mouth, down the pharynx past the epiglottis through the vocal cords and ventricular folds, and into the trachea, bypassing the esophagus. An inherent difficulty of this procedure is the blind entry past the epiglottis through the vocal cords. In some instances the passage through the vocal cords is difficult and the cords can be traumatized or damaged as a result of the tube not being properly guided. A significant application of the invention is to facilitate endotracheal tube placement. This is preferably accomplished by using a malleable endoscope that can be bent to the shape of the natural curve of the mouth - tracheal canal. The preshaped endoscope is then placed into the lumen of the endotracheal tube which then conforms to the shape of the endoscope. An apparatus in accordance with the invention is then attached to the eyepiece of the endoscope and allows a physician holding the camera housing to advance the scope/tube assembly through the mouth down along a properly positioned laryngoscope. While viewing the

image on the video monitor, the physician can visually guide the assembly down the pharynx through the vocal cords and into position in the trachea. The tube can then be fixed in place by inflating a balloon at its distal end prior to removing the scope. This same general procedure can be used for other applications such as passing an endotracheal tube through the nasal passages.

DESCRIPTION OF THE FIGURES

Figure 1 is an isometric front view of a first embodiment of a hand held apparatus device in accordance with the present invention;

Figure 2 is an isometric rear view of the apparatus of Figure 1;

Figure 3 is a left side view partially broke away, of the apparatus of Figure 1;

Figure 4 is a right side view, partially broken away, of the apparatus of Figure 1;

Figure 5 is an isometric view of the apparatus of Figure 1 depicting its attachment to a medical endoscope;

Figure 6 is a side view of a preferred embodiment of the invention including, (1) a camera housing, (2) a video monitor, and (3) an endoscope coupler, interconnected together;

Figure 7 is a side view of the embodiment of Figure 6 showing the modules detached and broken away to illustrate internal components;

Figure 8 is an exploded side view of the apparatus of Figure 6, additionally showing a power supply cable;

Figure 9 is a front view of the video monitor of Figure 8; and

Figure 10 is a rear view of a battery pack waist belt.

DESCRIPTION OF EMBODIMENTS

Attention is initially directed to Figures 1-6 which show a first embodiment of the invention particularly configured for medical applications. Figures 1 and 2 respectively show front and rear views of an imaging device in accordance with the invention comprising a hand held housing 1. The housing 1 includes at its distal or bottom end a standard endoscopic coupler 2. The coupler 2 is affixed to a handle 3 by means of a standard c-mount thread 4. Both endoscopic coupler 2 and device handle 3 can be constructed of either plastic or metal or any suitable rigid material. The handle 3 is of sufficient length to provide a comfortable grip for the user. Battery charger contacts 8 are located on the rear of the handle 3 for charging an internal battery via a standard battery charging unit. At the proximal end or top of the handle 3 is a switch 5 that can be easily depressed with the thumb to turn the device power on and off. Affixed to the handle 3 is a swivel mount 6. The swivel mount 6 supports upper housing 7 containing an LCD (liquid crystal display) monitor 9 enabling a user to position the LCD monitor screen to achieve the best viewing angle. User electronic control knobs 10 are mounted on upper housing 7 to enable a user to adjust the picture quality on the LCD screen 9. Knob 11 adjusts brightness. Knob 12 adjusts contrast and knob 13 adjust picture sharpness. An ACMI (American Cystoscope Manufacturers Inc.) endoscope light cable adapter 14 is provided to connect an internal light source (Figure 3) via an external cable to an endoscope (Figure 5) attached to the endoscopic coupler 2.

Figure 3 is a cut away view depicting the components within the housing 1. An industry standard c-mount thread 4 is cut into the proximal end of the device handle 3 for attachment of endoscopic coupler 2. Immediately proximal to the c-mount thread 4 is a camera 15 which is preferably comprised of a CCD chip 16 at its distal end and camera electronics 17. At the proximal end of the camera electronics are industry standard connectors 18 for affixing electrical wires 19 to power supply 20. Power supply 20 can comprise a 16 volt rechargeable battery power supply housed behind the LCD screen 9 and held in place by backer element 21.

Laterally opposite to the power supply 20 is a light reflector shield 22 that is affixed to bracket 23. Directly adjacent the light shield 22 is a high intensity light bulb 24. Light bulb 24 is connected to the power supply 20 by electrical wires (not shown). Immediately distal to bulb 24 is a glass buehl 25 which condenses and intensifies light emitted by bulb 24. Buehl 25 is terminated in light cable adapter 14.

Directly proximal the power supply chamber 26 and light source chamber 27 is the LCD monitor 9 with fully self contained electronics. LCD monitor 9 is connected to power supply 20 by electrical wires 28 and held in place by frame 29. Power supply 20 is connected by electrical wires 30 to power on/off switch 5.

Figure 5 depicts the video imaging device as it would be used with standard endoscope 31 in accordance with the invention. Endoscope 31 is comprised of an eyepiece housing 32 and endoscope shaft 33. Endoscope shaft 33 can be constructed from materials that are either flexible, rigid, or malleable. The shaft 33

is preferably comprised of a malleable aluminum alloy shaft. Affixed within the endoscope shaft 33 are illumination fibers 36 that are used to deliver light from the light source connector 14 to the shaft's distal end. Light cable 39 is connected to male connector 14 via female connectors 40. The light is transmitted to the endoscope via fiberoptics 41 to light cable connector 38 and transmitted via illumination fibers 36 to the distal tip of the endoscope. Adjacent and parallel to the illumination fibers at the distal tip of the endoscope is a lensing system 35 that captures an image and relays it to an image conduit 34. The image conduit 34 relays the image to a proximal lens system 37 that magnifies and relays the image from the image conduit to a series of lenses in the endoscopic coupler 2. The endoscopic coupler lens preferably magnify the image and relay it to the CCD chip 16 in camera 15. Electronics in the camera 15 converts the CCD chip signals to an appropriate video image format for driving LCD monitor 9.

Attention is now directed to figures 6-9 which depict a preferred structural embodiment 50 of the invention comprised primarily of the following detachable modules: a camera housing 52, a video monitor 54, and an endoscopic coupler 56.

The camera housing 52 comprises a hollow body 60 including a bottom portion 62 and a rounded upper portion 64 enclosing an internal chamber 66. The body 60 is preferably shaped and dimensioned so that it can be comfortably supported in the palm of a user's hand. An optical input port 68 and a video output port 70 are formed in the body 60 for functional interconnection to the endoscope coupler 56 and video monitor 54, respectively.

More particularly the optical input port 68 is formed by a cylindrical camera

mount fitting 74 secured in body opening 76. The camera mount fitting 74 is configured to detachably accommodate endoscopic coupler 56 which, in turn, is able to mate with the eyepiece of a standard medical endoscope (shown, for example, at 31 in Figure 5) to form a substantially rigid structural interconnection therewith.

One or more circuit boards 80 is mounted in the internal chamber 66 for carrying a solid state imaging sensor 82, e.g. an array of charge coupled devices (CCD's). The sensor 82 is located in the chamber 66 such that the collective effect of the lenses of coupler 56 and mount fitting 74 focuses an optical image, provided at the eyepiece of a coupled endoscope, onto the sensor 82. The sensor 82 is responsive to the optical image incident thereon to provide electronic signals representative thereof (via circuit paths not shown) to a connector 86 comprising part of the video output port 70 mounted adjacent body opening 88. The connector 86 comprises an electromechanical connector, preferably a female RJ45 connector, which is able to simultaneously form both an electrical and structural interconnection with a male RJ45 connector 90 mounted on the video monitor module 54.

In order to positively attach the camera housing 52 and monitor 54, a spring latch 92 is mounted in the housing 52 adjacent the female connector 86. When the male connector 90 is inserted into the female connector 86, spring latch 92 engages connector 90 to prevent its withdrawal. A latch release button 96 is mounted in the housing 52 and accessible to a user via body opening 98. Manual depression of button 96 forces latch 92 out of engagement with connector 90

enabling it to be withdrawn from connector 86.

Housing 52 further defines an electrical connection, e.g., power cord 100, for supplying electrical power to the sensor 82 and video monitor 54. Note that the housing 52 is devoid of any motors or motor driven parts thus enabling it to be sufficiently small in size and weight so that it can be comfortably supported in the palm of a user's hand.

The aforementioned male connector 90 is mounted on the video monitor 54, preferably via a relatively stiff swivel connection 104. More particularly, the male connector 90 is captured in an adapter 106 configured to be fastened, as by a threaded connection, to a ball 108. The ball 108 is accommodated in a socket 110 formed in the rear member 112 of the video monitor housing. One or more spring washers 116, mounted between housing rear member 112 and front member 118, frictionally engage ball 108, holding it tightly in socket 110. This structure enables the rear member 112 to be swiveled with respect to the ball 108 which is essentially fixed to the camera housing 52 via mail connector 90.

The monitor housing front member 118 is configured to be secured to rear member 112 by appropriate fastening (not shown). A liquid crystal display 122 and lens 124 are mounted between the rear and front housing members 112, 118. The display 122 is electronically driven from signals provided by male connector 90, for displaying an image on the front screen face 124 of housing front member 118. An adjustment wheel 125 is preferably provided to adjust display brightness.

The short power cord 100 terminates in connector 130 configured for interconnection with connector 132 on power cable 134. Power cable 134

preferably includes an in-line voltage converter 136 for converting standard AC power line voltage to low voltage DC. Converter 136 is adapted to be connected via connector 138 on cable 140 to a standard power plug 142. Power cable 134 preferably also includes a video signal line extending from camera housing 52 via power cord 100 to a video connector 144 for optionally driving a remote video device, e.g., display or VCR.

Figure 10 illustrates a waist belt 150 having fastenable ends 151A, 151B which can be worn by a user to carry a battery pack 152. A power cord 154 is electrically connected to the battery pack and extends from the waist belt 150 terminating in connector 156. Connector 156 is configured for coupling to connector 130, alternative to the power cable 134. The use of the battery pack waist belt 150 frees the physician user from having to be tethered to an AC outlet.

From the foregoing, it should now be appreciated that a camera housing has been disclosed herein characterized by being light in weight and small in size attributable to its containing a solid state imaging sensor but being devoid of any motor driven parts. As a consequence, it can be readily configured, as shown in Figures 6-9 so it can be held in a physician user's palm. By connecting the camera housing 52 via a detachable substantially rigid connection to an endoscope, the user is able to readily hold the housing and conveniently manipulate the endoscope as by applying an axial pulling or pushing force. Further, by connecting the camera housing via an adjustable electromechanical connector to a video monitor, the user is able to readily swivel the monitor to a comfortable viewing position. The adjustable electromechanical connector preferably provides a stiff swivel

substantially rigid structural attachment enabling the user to handle the apparatus 50 with an attached endoscope as an essentially integral structure. The detachable electromechanical connection between the camera housing and video monitor also enables the user to selectively interpose a flexible cable to enable the video monitor to be mounted remote from the camera housing, as on a table or I.V. pole, for certain medical procedures.

Although a limited number of specific embodiments have been described herein, it should be understood that various modifications will occur to those skilled in the art which are intended to be encompassed by the spirit and scope of the attached claims.

CLAIMS

1. An apparatus suitable for attachment to the proximal end of an endoscope for displaying to a user a video image representative of a target site at the distal end of said endoscope, said apparatus comprising:

a housing devoid of motor driven parts and externally configured to be held in a user's hand;

a coupler mounted on said housing for coupling to the proximal end of an endoscope;

a solid state imaging sensor mounted in said housing responsive to an optical image presented by said endoscope proximal end for producing electronic signals representative thereof; and

a video monitor responsive to said electronic signals for producing a video image representative of said optical image.

2. The apparatus of claim 1 wherein said housing defines an optical input port; and wherein

said coupler is located adjacent to said optical input port for detachably mounting said endoscope proximal end adjacent thereto.

3. The apparatus of claim 1 wherein said housing has a video output port comprised of a first electromechanical connector; and wherein

said video monitor carries a second electromechanical connector configured

to mate with said first electromechanical connector for providing both an electrical interconnection and a substantially rigid structural attachment.

4. The apparatus of claim 3 wherein said first and second electromechanical connectors are configured for selective attachment and detachment.

5. The apparatus of claim 1 wherein said video monitor is adjustably mounted to said housing for adjustable movement relative thereto.

6. The apparatus of claim 4 wherein said second electromechanical connector is mounted for swivel movement relative to said video monitor to enable adjustment of the relative orientation between said housing and said video monitor.

7. The apparatus of claim 1 wherein said video monitor is comprised of a solid state display.

8. A video imaging apparatus suitable for attachment to the proximal end of an endoscope for displaying an image of a target site at the distal end of said endoscope, said apparatus comprising:

a housing configured to be held in the user's hand;

a coupler mounted on said housing configured to substantially rigidly couple to the proximal end of an endoscope;

an imaging sensor mounted in said housing responsive to visual image

information supplied by said endoscope for producing electronic signals representative thereof;

a display device responsive to said electronic signals for producing a visual representation of said visual image information; and

detachable electromechanical connector means for electrically interconnecting and substantially rigidly structurally attaching said display device to said housing.

9. The apparatus of claim 8 wherein said housing is devoid of any motor driven parts.

10. The apparatus of claim 8 wherein said connector means includes a swivel connection mounted between said display device and said housing for adjusting the orientation of said display device relative to said housing.

11. The apparatus of claim 8 wherein said display device comprises a liquid crystal display.

12. The apparatus of claim 8 wherein said imaging sensor is comprised of charge coupled devices.

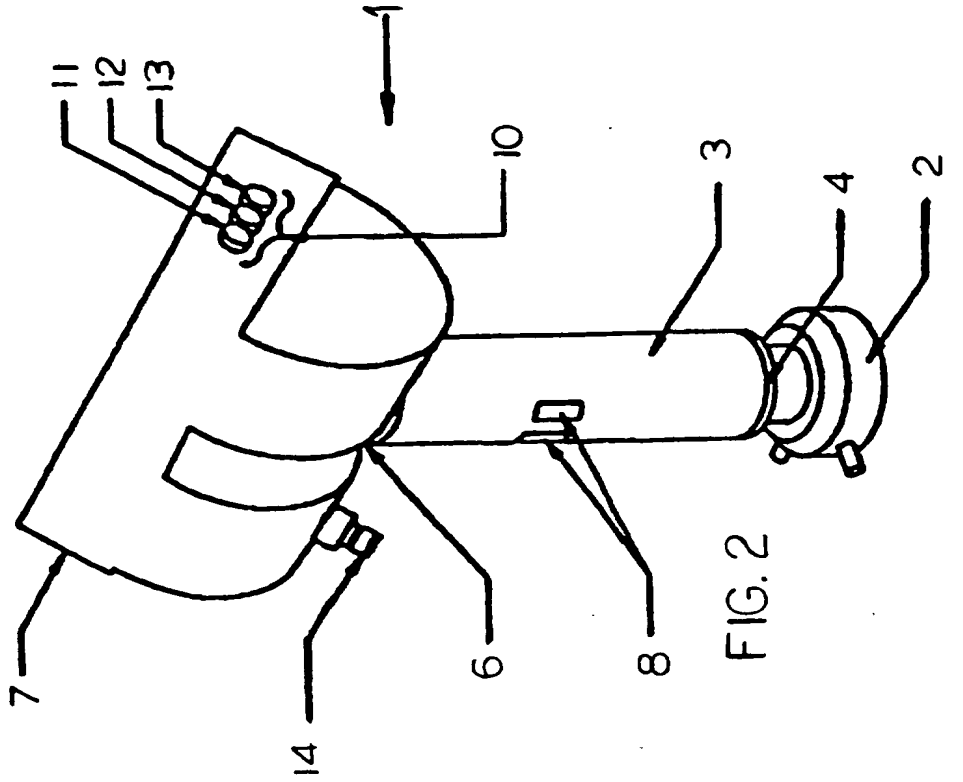

FIG. 2

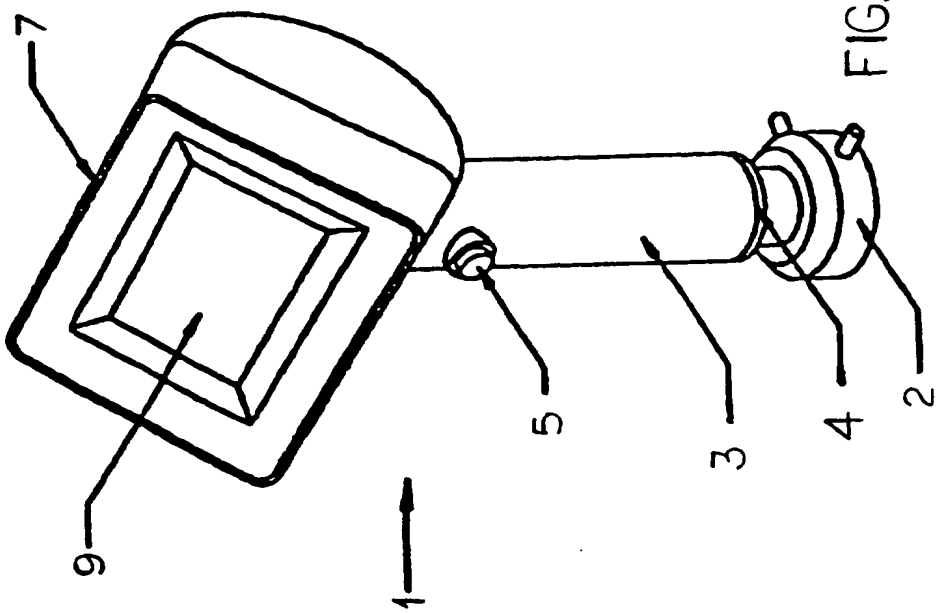

FIG. 1

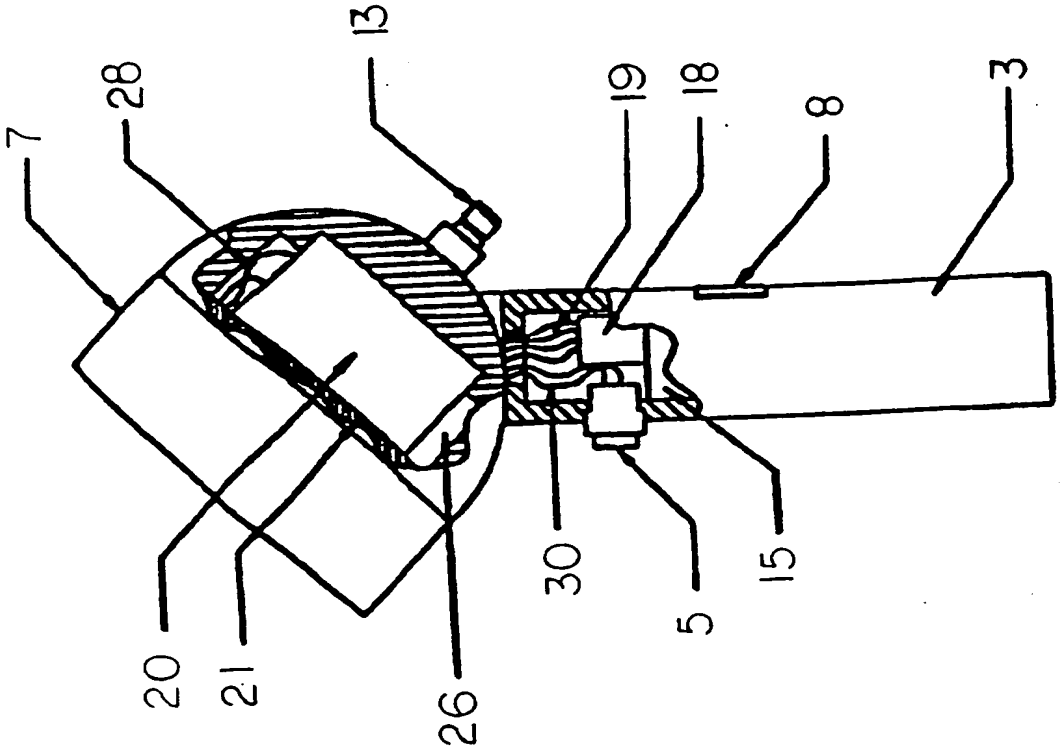
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FIG. 4

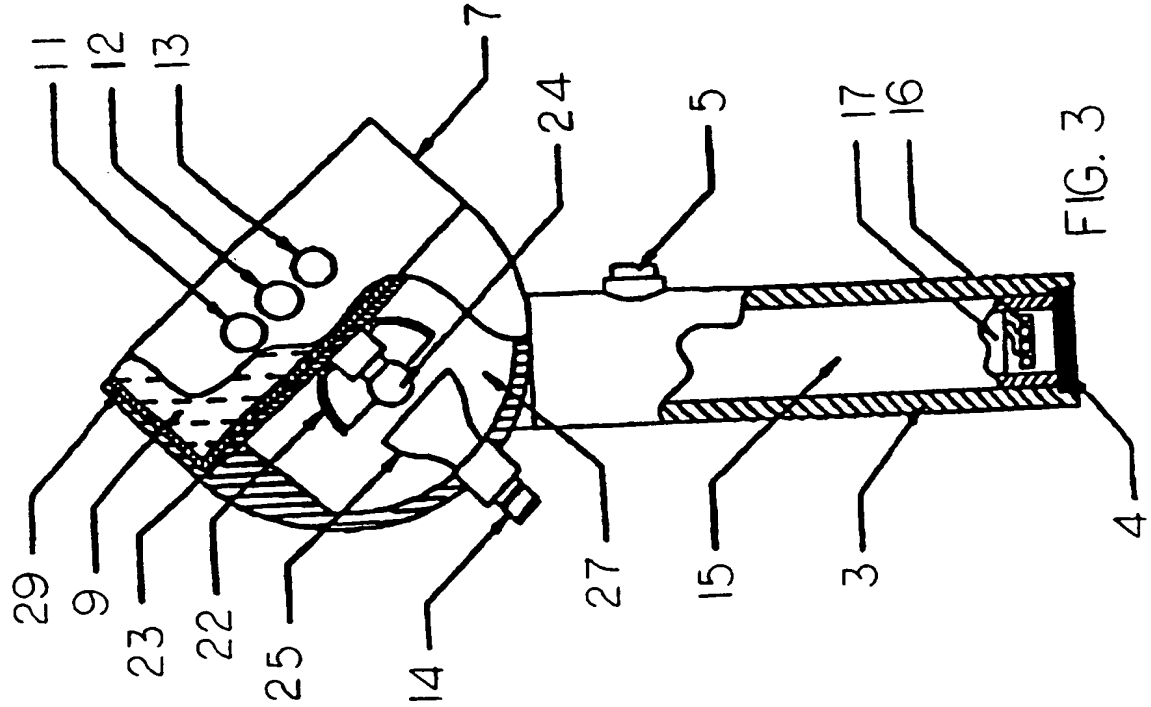
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FIG. 3

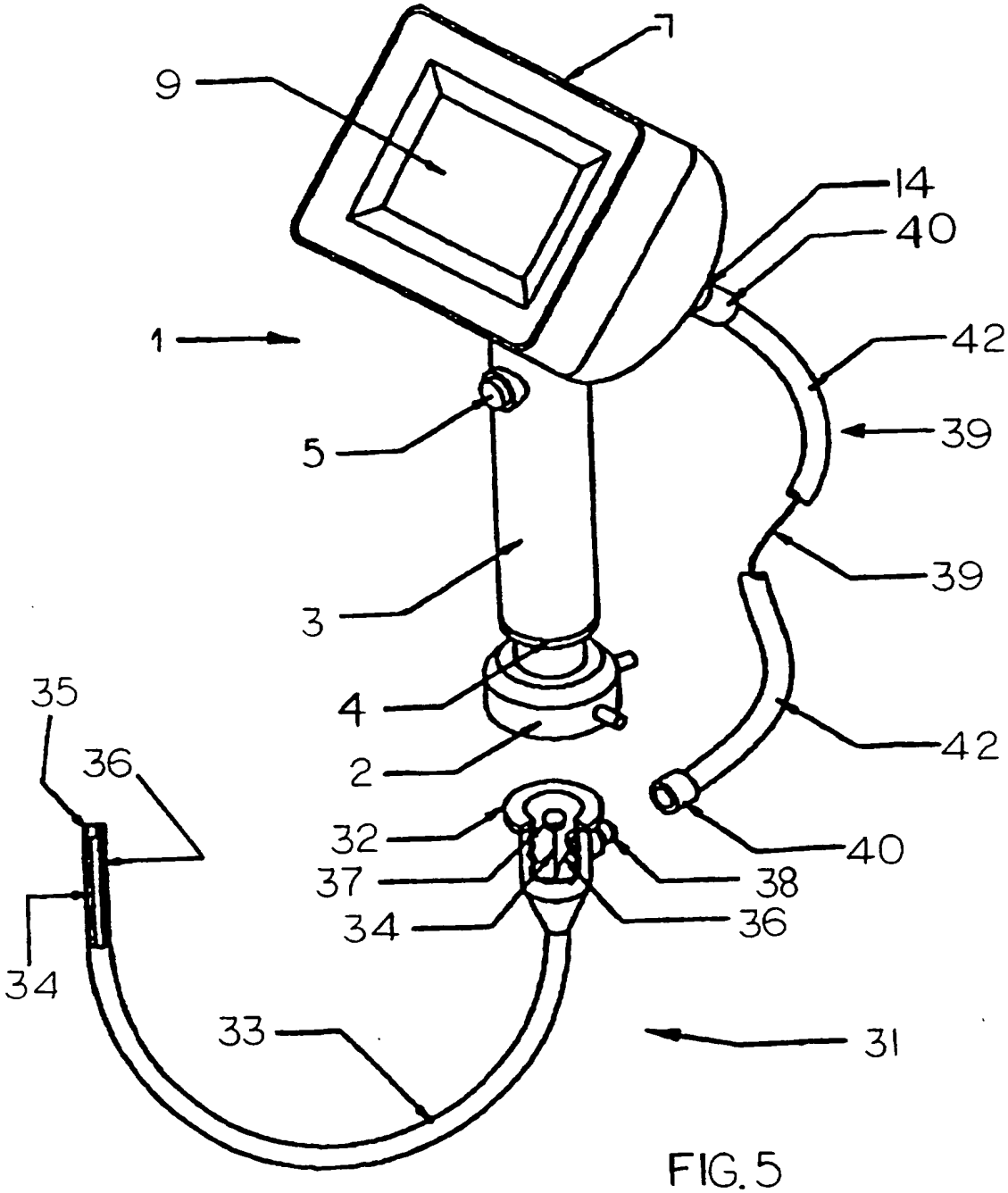

FIG. 5

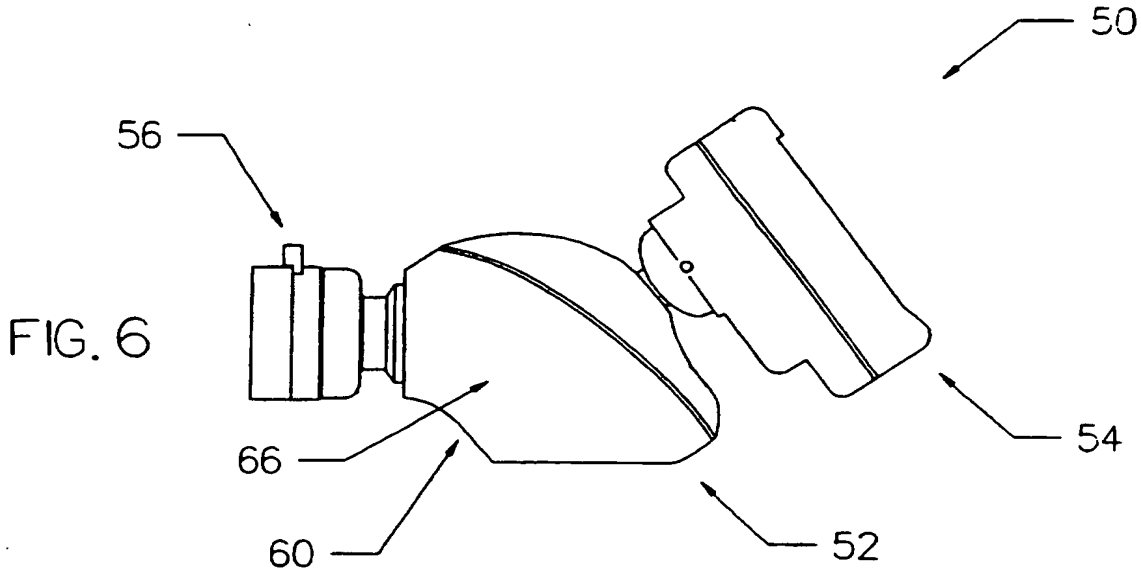

FIG. 6

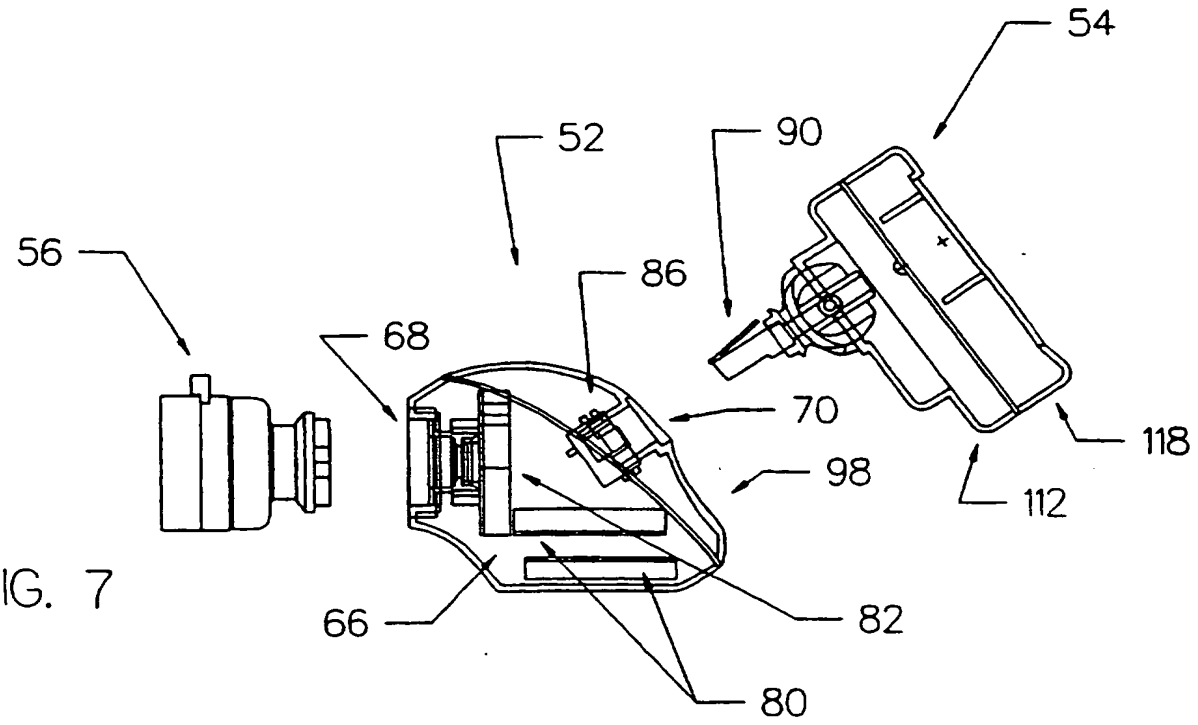

FIG. 7

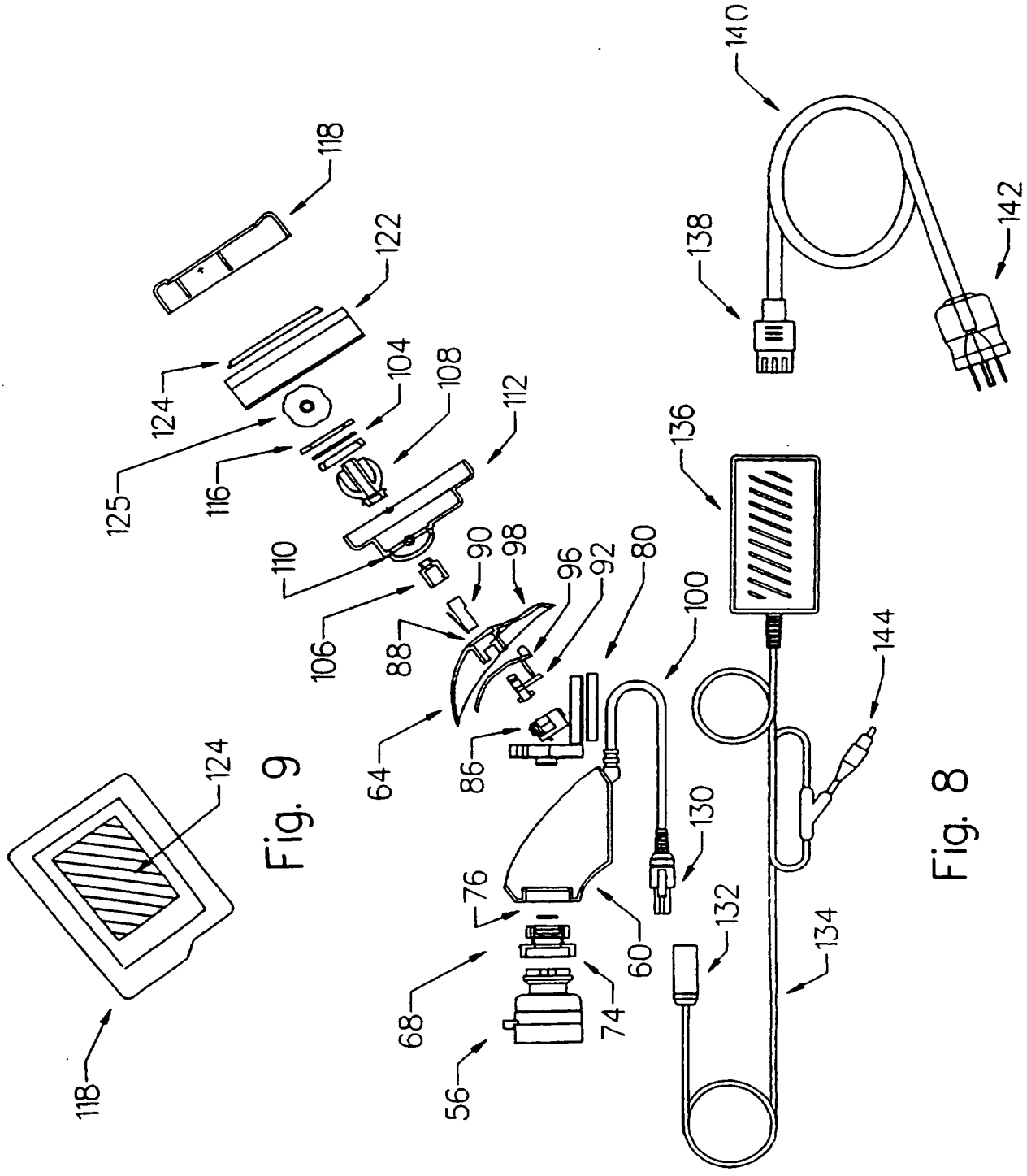

Fig. 8

Fig. 9

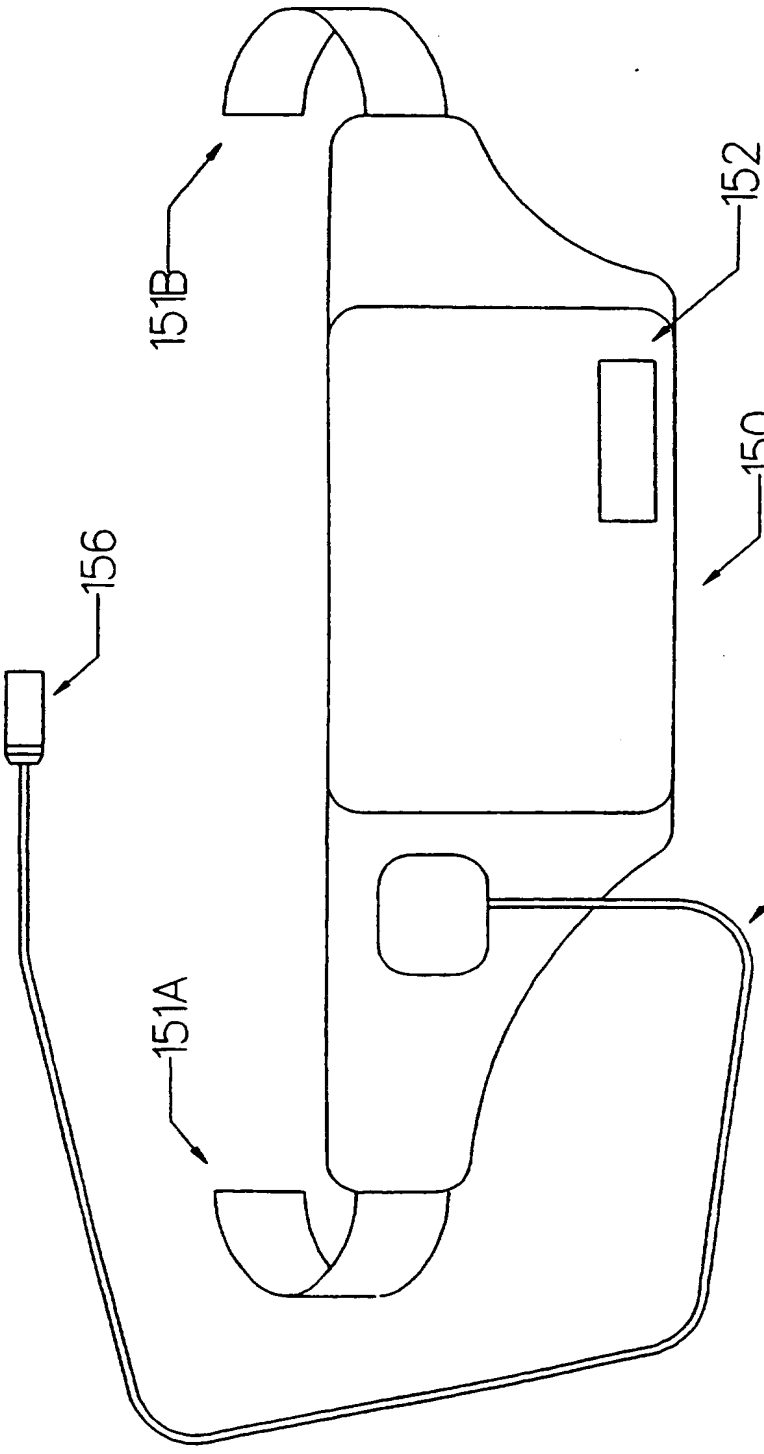

Fig. 10

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04N 7/18
US CL :348/65, 75; 600/101, 109
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 348/65, 71, 72, 75; 600/101, 109

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 4,926,258 (SASAKI ET AL) 15 MAY 1990, COLS. 3-6, 15.	1-12
A	US, A, 5,270,810 (NISHIMURA) 14 DECEMBER 1993.	1-12
A	US, A, 5,142,359 (YAMAMORI) 25 AUGUST 1992.	1-12
A	US, A, 4,253,447 (MOORE ET AL) 03 MARCH 1981.	1-12

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Date of the actual completion of the international search	Date of mailing of the international search report
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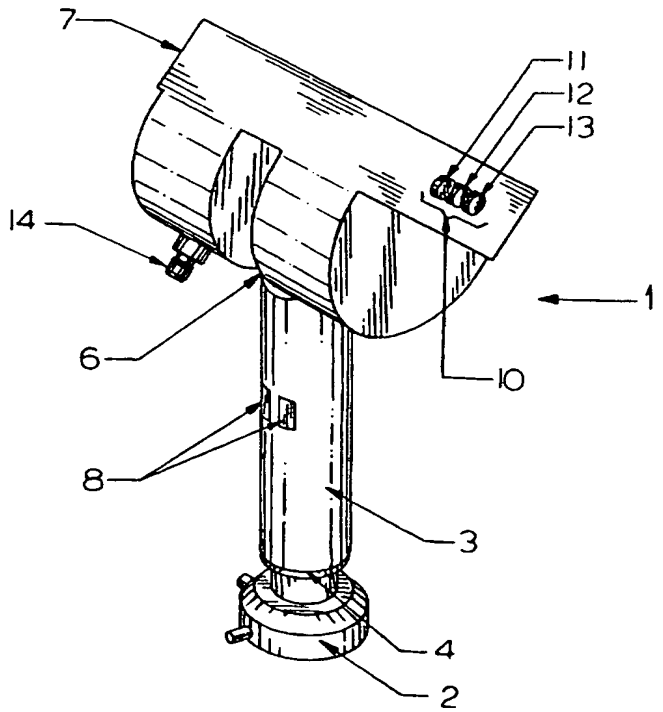
(54) Title: HAND-HELD IMAGING APPARATUS FOR USE WITH ENDOSCOPES

(57) Abstract

An apparatus particularly configured for coupling to the proximal end of a medical endoscope for presenting a video image of the target site at the distal end of the endoscope. The apparatus is comprised of (1) a camera housing containing a solid state electronic imaging sensor, (2) a video monitor, and (3) an endoscope coupler, wherein the camera housing contains no motor driven parts and the housing exterior is dimensioned and shaped so that it can be readily held in a user's hand. The video monitor is configured for detachable attachment to the camera housing via an electromechanical connector which affords both an electrical interconnection and an adjustable substantially rigid structural attachment.



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TITLE : **HAND HELD IMAGING APPARATUS FOR USE WITH ENDOSCOPES**

BACKGROUND OF THE INVENTION

This invention relates to a hand held apparatus particularly configured for attachment to the proximal end of a medical endoscope for producing a video image representative of a target site at the distal end of the endoscope.

Traditionally, when using a medical endoscope, a physician places his eye directly against an eyepiece at the endoscope's proximal end. The typical endoscope contains a lens at its distal end for gathering an image of the target site and optically coupling the image via optical fibers to the endoscope eyepiece. A high intensity light source is generally provided for illuminating the target site to enhance image gathering.

In recent years, video monitoring systems for medical applications have been made available which utilize an electronic camera head for capturing the image at the endoscope eyepiece. The captured image is then relayed via electronic cables to a cart mounted subsystem which converts the image to a standard NTSC or PAL video format for driving a CRT (cathode ray tube) monitor. Such systems are marketed commercially by various companies and are typically comprised of a large mobile cart on wheels which carries camera control electronics, a CRT monitor, and a high intensity light source. As a consequence, they are typically cumbersome, expensive, and occupy a lot of valuable space.

Additionally, it is believed that commercially available camcorders have been

used in conjunction with flexible boroscopes for industrial applications to provide a user with a convenient video image remote from a target site at the scope distal end. Although the size and weight of available camcorders have diminished over the years, they are still too large and heavy, attributable in part to their motor driven feed systems, to be conveniently used for many medical procedures.

SUMMARY OF THE INVENTION

The present invention is directed to an apparatus particularly configured for coupling to the proximal end of a medical endoscope for presenting a video image of the target site at the distal end of the endoscope.

Apparatus in accordance with the invention is comprised of (1) a camera housing containing a solid state electronic imaging sensor, (2) a video monitor, and (3) an endoscope coupler, wherein the camera housing contains no motor driven parts and the housing exterior is dimensioned and shaped so that it can be readily held in a user's hand.

In accordance with a preferred embodiment, the video monitor is configured for detachable attachment to the camera housing via an electromechanical connector which affords both an electrical interconnection and an adjustable substantially rigid structural attachment.

In the preferred embodiment, the camera housing defines an optical input port and a video output port. A mount is provided on the housing for accommodating the endoscope coupler which is configured for detachable rigid attachment to the endoscope eyepiece. When attached, the endoscope eyepiece

can focus an image, via the coupler and through the input port, onto an imaging sensor in the camera housing. The imaging sensor preferably comprises an array of charge coupled devices (CCD) mounted at the focal plane of the coupler lens system.

The video output port is preferably formed by one half of an electromechanical connector configured for detachable attachment to a mating connector carried by the video monitor, e.g. a liquid crystal display (LCD) screen. In a preferred embodiment, the camera housing output port comprises a female connector (e.g., RJ45) and the video monitor carries a mating male connector. The male and female connectors are constructed so that when engaged, they provide both an electrical interconnection and a substantially rigid structural attachment.

As a consequence of the rigid attachments between the camera housing, the video monitor, and the endoscope coupler and eyepiece, a physician is able to hold the camera housing in one hand and position the endoscope for convenient manipulation and the video monitor for comfortable viewing.

In accordance with a significant feature of the preferred embodiment, the male connector is connected by a stiff swivel mount to the video monitor for enabling a physician to adjustably position the monitor relative to the hand held camera housing to enhance the physician's flexibility of use and viewing comfort.

In accordance with a further feature of the preferred embodiment, a flexible electric cable can be interposed between the aforementioned male and female connectors to enable the video monitor to be physically displaced from the camera housing. This feature enables a physician to selectively mount the monitor in a

variety of manners such as on a table, on an I.V. pole, in a sternum or head mount harness, etc.

In accordance with a still further feature of the preferred embodiment, a flexible power cable is provided for connecting the camera housing to a power source. The cable preferably includes a video signal line for driving a remote video monitor or video recorder.

Embodiments of the invention can be advantageously employed in many different applications including, for example, the endoscopically directed placement of endotracheal tubes. This procedure involves insertion of the endotracheal tube through the mouth, down the pharynx past the epiglottis through the vocal cords and ventricular folds, and into the trachea, bypassing the esophagus. An inherent difficulty of this procedure is the blind entry past the epiglottis through the vocal cords. In some instances the passage through the vocal cords is difficult and the cords can be traumatized or damaged as a result of the tube not being properly guided. A significant application of the invention is to facilitate endotracheal tube placement. This is preferably accomplished by using a malleable endoscope that can be bent to the shape of the natural curve of the mouth - tracheal canal. The preshaped endoscope is then placed into the lumen of the endotracheal tube which then conforms to the shape of the endoscope. An apparatus in accordance with the invention is then attached to the eyepiece of the endoscope and allows a physician holding the camera housing to advance the scope/tube assembly through the mouth down along a properly positioned laryngoscope. While viewing the

image on the video monitor, the physician can visually guide the assembly down the pharynx through the vocal cords and into position in the trachea. The tube can then be fixed in place by inflating a balloon at its distal end prior to removing the scope. This same general procedure can be used for other applications such as passing an endotracheal tube through the nasal passages.

DESCRIPTION OF THE FIGURES

Figure 1 is an isometric front view of a first embodiment of a hand held apparatus device in accordance with the present invention;

Figure 2 is an isometric rear view of the apparatus of Figure 1;

Figure 3 is a left side view partially broke away, of the apparatus of Figure 1;

Figure 4 is a right side view, partially broken away, of the apparatus of Figure 1;

Figure 5 is an isometric view of the apparatus of Figure 1 depicting its attachment to a medical endoscope;

Figure 6 is a side view of a preferred embodiment of the invention including, (1) a camera housing, (2) a video monitor, and (3) an endoscope coupler, interconnected together;

Figure 7 is a side view of the embodiment of Figure 6 showing the modules detached and broken away to illustrate internal components;

Figure 8 is an exploded side view of the apparatus of Figure 6, additionally showing a power supply cable;

Figure 9 is a front view of the video monitor of Figure 8; and

Figure 10 is a rear view of a battery pack waist belt.

DESCRIPTION OF EMBODIMENTS

Attention is initially directed to Figures 1-6 which show a first embodiment of the invention particularly configured for medical applications. Figures 1 and 2 respectively show front and rear views of an imaging device in accordance with the invention comprising a hand held housing 1. The housing 1 includes at its distal or bottom end a standard endoscopic coupler 2. The coupler 2 is affixed to a handle 3 by means of a standard c-mount thread 4. Both endoscopic coupler 2 and device handle 3 can be constructed of either plastic or metal or any suitable rigid material. The handle 3 is of sufficient length to provide a comfortable grip for the user. Battery charger contacts 8 are located on the rear of the handle 3 for charging an internal battery via a standard battery charging unit. At the proximal end or top of the handle 3 is a switch 5 that can be easily depressed with the thumb to turn the device power on and off. Affixed to the handle 3 is a swivel mount 6. The swivel mount 6 supports upper housing 7 containing an LCD (liquid crystal display) monitor 9 enabling a user to position the LCD monitor screen to achieve the best viewing angle. User electronic control knobs 10 are mounted on upper housing 7 to enable a user to adjust the picture quality on the LCD screen 9. Knob 11 adjusts brightness. Knob 12 adjusts contrast and knob 13 adjust picture sharpness. An ACMI (American Cystoscope Manufacturers Inc.) endoscope light cable adapter 14 is provided to connect an internal light source (Figure 3) via an external cable to an endoscope (Figure 5) attached to the endoscopic coupler 2.

Figure 3 is a cut away view depicting the components within the housing 1. An industry standard c-mount thread 4 is cut into the proximal end of the device handle 3 for attachment of endoscopic coupler 2. Immediately proximal to the c-mount thread 4 is a camera 15 which is preferably comprised of a CCD chip 16 at its distal end and camera electronics 17. At the proximal end of the camera electronics are industry standard connectors 18 for affixing electrical wires 19 to power supply 20. Power supply 20 can comprise a 16 volt rechargeable battery power supply housed behind the LCD screen 9 and held in place by backer element 21.

Laterally opposite to the power supply 20 is a light reflector shield 22 that is affixed to bracket 23. Directly adjacent the light shield 22 is a high intensity light bulb 24. Light bulb 24 is connected to the power supply 20 by electrical wires (not shown). Immediately distal to bulb 24 is a glass buehl 25 which condenses and intensifies light emitted by bulb 24. Buehl 25 is terminated in light cable adapter 14.

Directly proximal the power supply chamber 26 and light source chamber 27 is the LCD monitor 9 with fully self contained electronics. LCD monitor 9 is connected to power supply 20 by electrical wires 28 and held in place by frame 29. Power supply 20 is connected by electrical wires 30 to power on/off switch 5.

Figure 5 depicts the video imaging device as it would be used with standard endoscope 31 in accordance with the invention. Endoscope 31 is comprised of an eyepiece housing 32 and endoscope shaft 33. Endoscope shaft 33 can be constructed from materials that are either flexible, rigid, or malleable. The shaft 33

is preferably comprised of a malleable aluminum alloy shaft. Affixed within the endoscope shaft 33 are illumination fibers 36 that are used to deliver light from the light source connector 14 to the shaft's distal end. Light cable 39 is connected to male connector 14 via female connectors 40. The light is transmitted to the endoscope via fiberoptics 41 to light cable connector 38 and transmitted via illumination fibers 36 to the distal tip of the endoscope. Adjacent and parallel to the illumination fibers at the distal tip of the endoscope is a lensing system 35 that captures an image and relays it to an image conduit 34. The image conduit 34 relays the image to a proximal lens system 37 that magnifies and relays the image from the image conduit to a series of lenses in the endoscopic coupler 2. The endoscopic coupler lens preferably magnify the image and relay it to the CCD chip 16 in camera 15. Electronics in the camera 15 converts the CCD chip signals to an appropriate video image format for driving LCD monitor 9.

Attention is now directed to figures 6-9 which depict a preferred structural embodiment 50 of the invention comprised primarily of the following detachable modules: a camera housing 52, a video monitor 54, and an endoscopic coupler 56.

The camera housing 52 comprises a hollow body 60 including a bottom portion 62 and a rounded upper portion 64 enclosing an internal chamber 66. The body 60 is preferably shaped and dimensioned so that it can be comfortably supported in the palm of a user's hand. An optical input port 68 and a video output port 70 are formed in the body 60 for functional interconnection to the endoscope coupler 56 and video monitor 54, respectively.

More particularly the optical input port 68 is formed by a cylindrical camera

mount fitting 74 secured in body opening 76. The camera mount fitting 74 is configured to detachably accommodate endoscopic coupler 56 which, in turn, is able to mate with the eyepiece of a standard medical endoscope (shown, for example, at 31 in Figure 5) to form a substantially rigid structural interconnection therewith.

One or more circuit boards 80 is mounted in the internal chamber 66 for carrying a solid state imaging sensor 82, e.g. an array of charge coupled devices (CCD's). The sensor 82 is located in the chamber 66 such that the collective effect of the lenses of coupler 56 and mount fitting 74 focuses an optical image, provided at the eyepiece of a coupled endoscope, onto the sensor 82. The sensor 82 is responsive to the optical image incident thereon to provide electronic signals representative thereof (via circuit paths not shown) to a connector 86 comprising part of the video output port 70 mounted adjacent body opening 88. The connector 86 comprises an electromechanical connector, preferably a female RJ45 connector, which is able to simultaneously form both an electrical and structural interconnection with a male RJ45 connector 90 mounted on the video monitor module 54.

In order to positively attach the camera housing 52 and monitor 54, a spring latch 92 is mounted in the housing 52 adjacent the female connector 86. When the male connector 90 is inserted into the female connector 86, spring latch 92 engages connector 90 to prevent its withdrawal. A latch release button 96 is mounted in the housing 52 and accessible to a user via body opening 98. Manual depression of button 96 forces latch 92 out of engagement with connector 90

enabling it to be withdrawn from connector 86.

Housing 52 further defines an electrical connection, e.g., power cord 100, for supplying electrical power to the sensor 82 and video monitor 54. Note that the housing 52 is devoid of any motors or motor driven parts thus enabling it to be sufficiently small in size and weight so that it can be comfortably supported in the palm of a user's hand.

The aforementioned male connector 90 is mounted on the video monitor 54, preferably via a relatively stiff swivel connection 104. More particularly, the male connector 90 is captured in an adapter 106 configured to be fastened, as by a threaded connection, to a ball 108. The ball 108 is accommodated in a socket 110 formed in the rear member 112 of the video monitor housing. One or more spring washers 116, mounted between housing rear member 112 and front member 118, frictionally engage ball 108, holding it tightly in socket 110. This structure enables the rear member 112 to be swiveled with respect to the ball 108 which is essentially fixed to the camera housing 52 via mail connector 90.

The monitor housing front member 118 is configured to be secured to rear member 112 by appropriate fastening (not shown). A liquid crystal display 122 and lens 124 are mounted between the rear and front housing members 112, 118. The display 122 is electronically driven from signals provided by male connector 90, for displaying an image on the front screen face 124 of housing front member 118. An adjustment wheel 125 is preferably provided to adjust display brightness.

The short power cord 100 terminates in connector 130 configured for interconnection with connector 132 on power cable 134. Power cable 134

preferably includes an in-line voltage converter 136 for converting standard AC power line voltage to low voltage DC. Converter 136 is adapted to be connected via connector 138 on cable 140 to a standard power plug 142. Power cable 134 preferably also includes a video signal line extending from camera housing 52 via power cord 100 to a video connector 144 for optionally driving a remote video device, e.g., display or VCR.

Figure 10 illustrates a waist belt 150 having fastenable ends 151A, 151B which can be worn by a user to carry a battery pack 152. A power cord 154 is electrically connected to the battery pack and extends from the waist belt 150 terminating in connector 156. Connector 156 is configured for coupling to connector 130, alternative to the power cable 134. The use of the battery pack waist belt 150 frees the physician user from having to be tethered to an AC outlet.

From the foregoing, it should now be appreciated that a camera housing has been disclosed herein characterized by being light in weight and small in size attributable to its containing a solid state imaging sensor but being devoid of any motor driven parts. As a consequence, it can be readily configured, as shown in Figures 6-9 so it can be held in a physician user's palm. By connecting the camera housing 52 via a detachable substantially rigid connection to an endoscope, the user is able to readily hold the housing and conveniently manipulate the endoscope as by applying an axial pulling or pushing force. Further, by connecting the camera housing via an adjustable electromechanical connector to a video monitor, the user is able to readily swivel the monitor to a comfortable viewing position. The adjustable electromechanical connector preferably provides a stiff swivel

substantially rigid structural attachment enabling the user to handle the apparatus 50 with an attached endoscope as an essentially integral structure. The detachable electromechanical connection between the camera housing and video monitor also enables the user to selectively interpose a flexible cable to enable the video monitor to be mounted remote from the camera housing, as on a table or I.V. pole, for certain medical procedures.

Although a limited number of specific embodiments have been described herein, it should be understood that various modifications will occur to those skilled in the art which are intended to be encompassed by the spirit and scope of the attached claims.

CLAIMS

1. An apparatus suitable for attachment to the proximal end of an endoscope for displaying to a user a video image representative of a target site at the distal end of said endoscope, said apparatus comprising:

a housing devoid of motor driven parts and externally configured to be held in a user's hand;

a coupler mounted on said housing for coupling to the proximal end of an endoscope;

a solid state imaging sensor mounted in said housing responsive to an optical image presented by said endoscope proximal end for producing electronic signals representative thereof; and

a video monitor responsive to said electronic signals for producing a video image representative of said optical image.

2. The apparatus of claim 1 wherein said housing defines an optical input port; and wherein

said coupler is located adjacent to said optical input port for detachably mounting said endoscope proximal end adjacent thereto.

3. The apparatus of claim 1 wherein said housing has a video output port comprised of a first electromechanical connector; and wherein

said video monitor carries a second electromechanical connector configured

to mate with said first electromechanical connector for providing both an electrical interconnection and a substantially rigid structural attachment.

4. The apparatus of claim 3 wherein said first and second electromechanical connectors are configured for selective attachment and detachment.

5. The apparatus of claim 1 wherein said video monitor is adjustably mounted to said housing for adjustable movement relative thereto.

6. The apparatus of claim 4 wherein said second electromechanical connector is mounted for swivel movement relative to said video monitor to enable adjustment of the relative orientation between said housing and said video monitor.

7. The apparatus of claim 1 wherein said video monitor is comprised of a solid state display.

8. A video imaging apparatus suitable for attachment to the proximal end of an endoscope for displaying an image of a target site at the distal end of said endoscope, said apparatus comprising:

a housing configured to be held in the user's hand;

a coupler mounted on said housing configured to substantially rigidly couple to the proximal end of an endoscope;

an imaging sensor mounted in said housing responsive to visual image

information supplied by said endoscope for producing electronic signals representative thereof;

a display device responsive to said electronic signals for producing a visual representation of said visual image information; and

detachable electromechanical connector means for electrically interconnecting and substantially rigidly structurally attaching said display device to said housing.

9. The apparatus of claim 8 wherein said housing is devoid of any motor driven parts.

10. The apparatus of claim 8 wherein said connector means includes a swivel connection mounted between said display device and said housing for adjusting the orientation of said display device relative to said housing.

11. The apparatus of claim 8 wherein said display device comprises a liquid crystal display.

12. The apparatus of claim 8 wherein said imaging sensor is comprised of charge coupled devices.

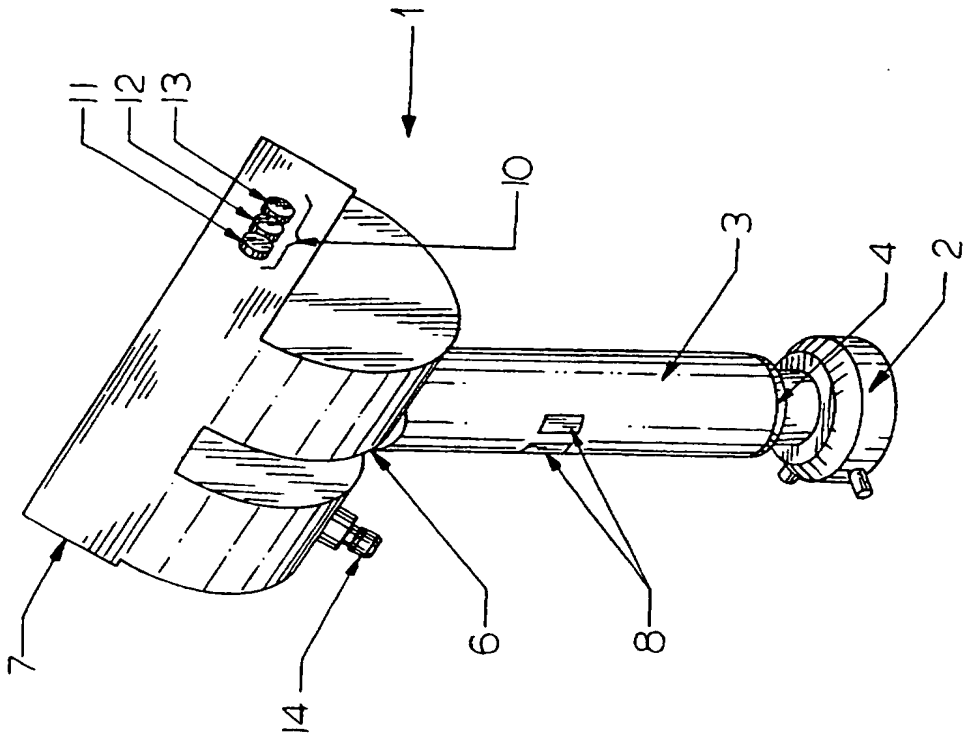

FIG. 2

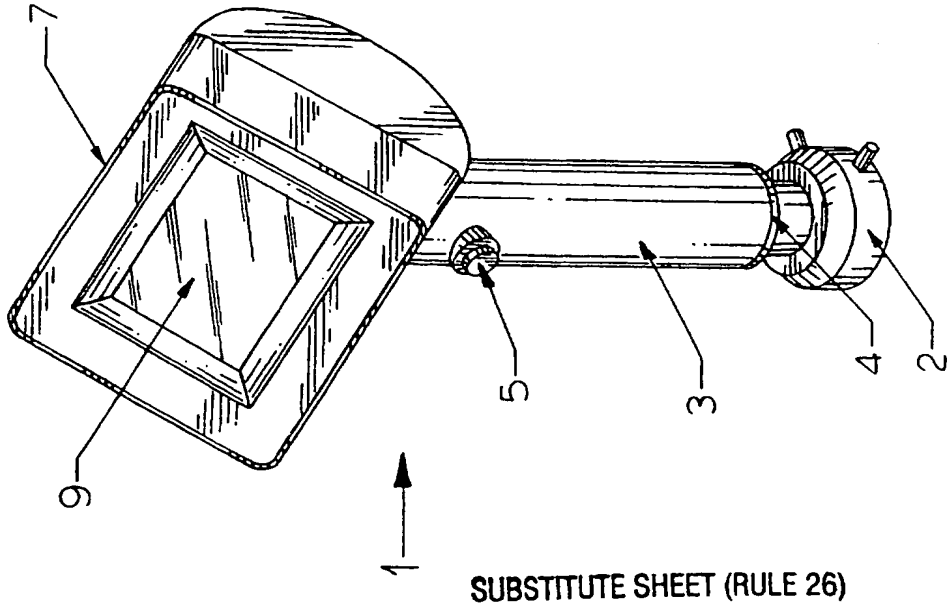

FIG. 1

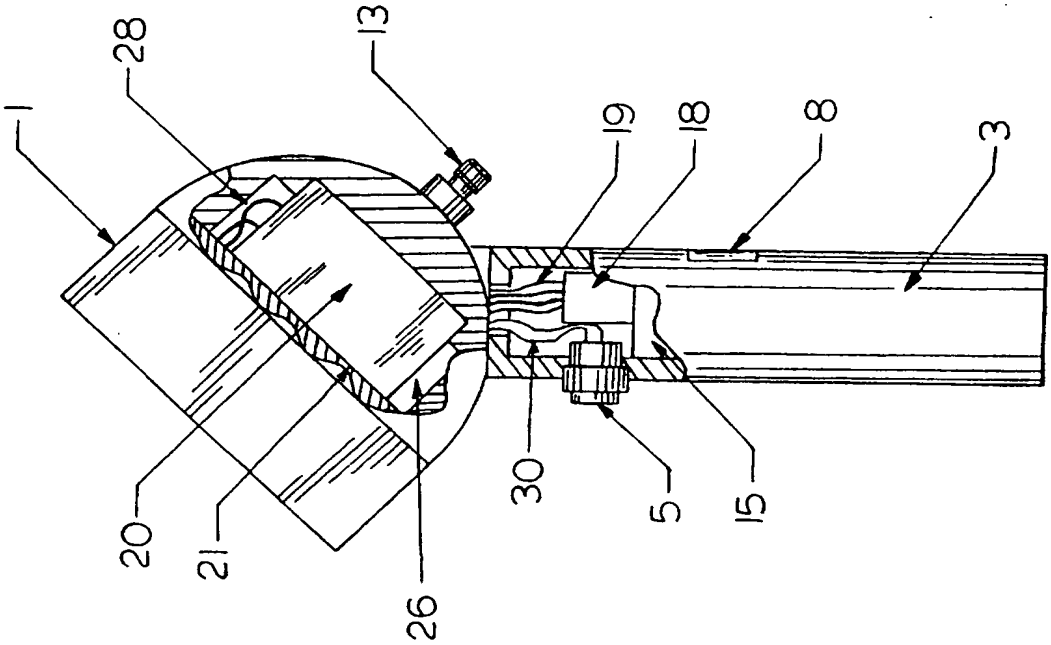

FIG. 4

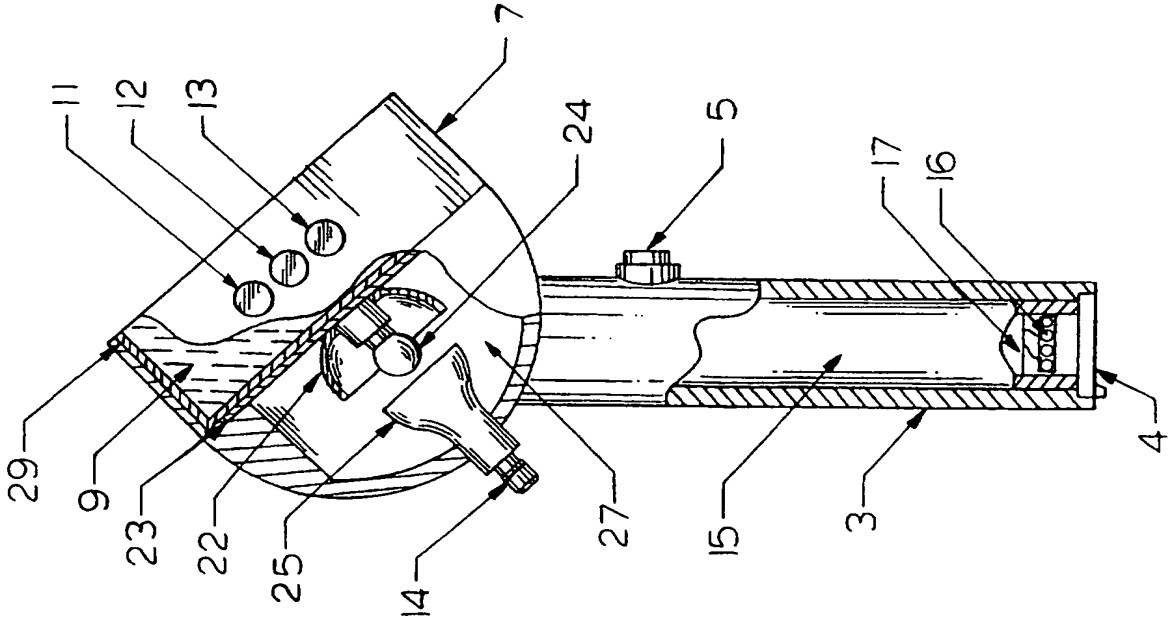

FIG. 3

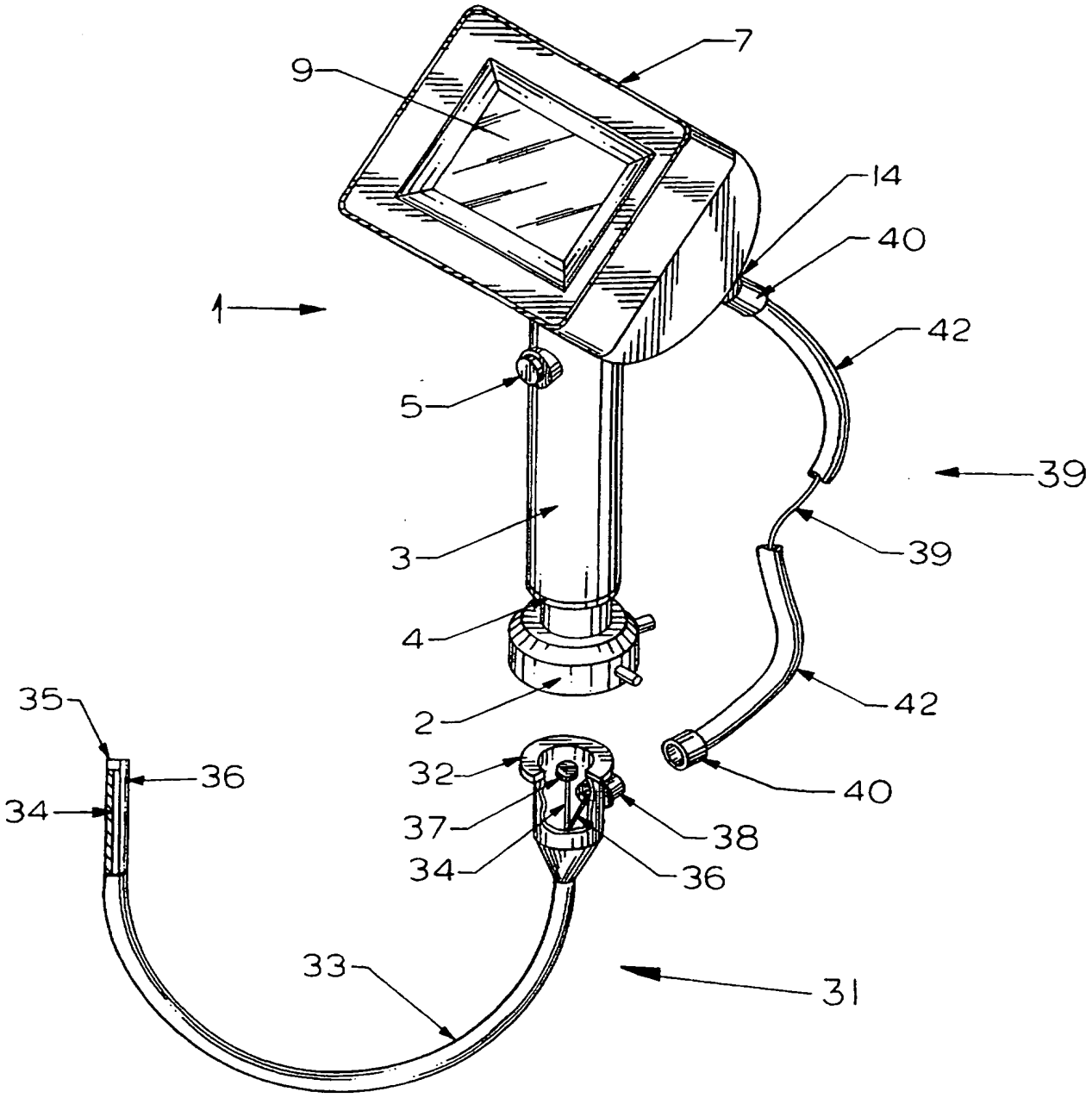

FIG. 5

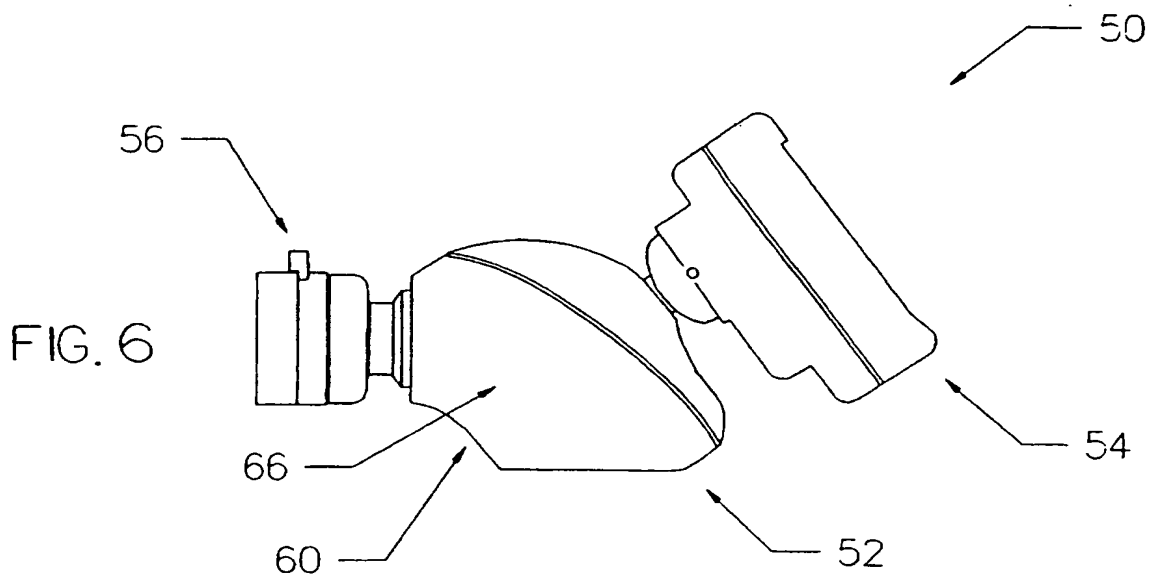

FIG. 6

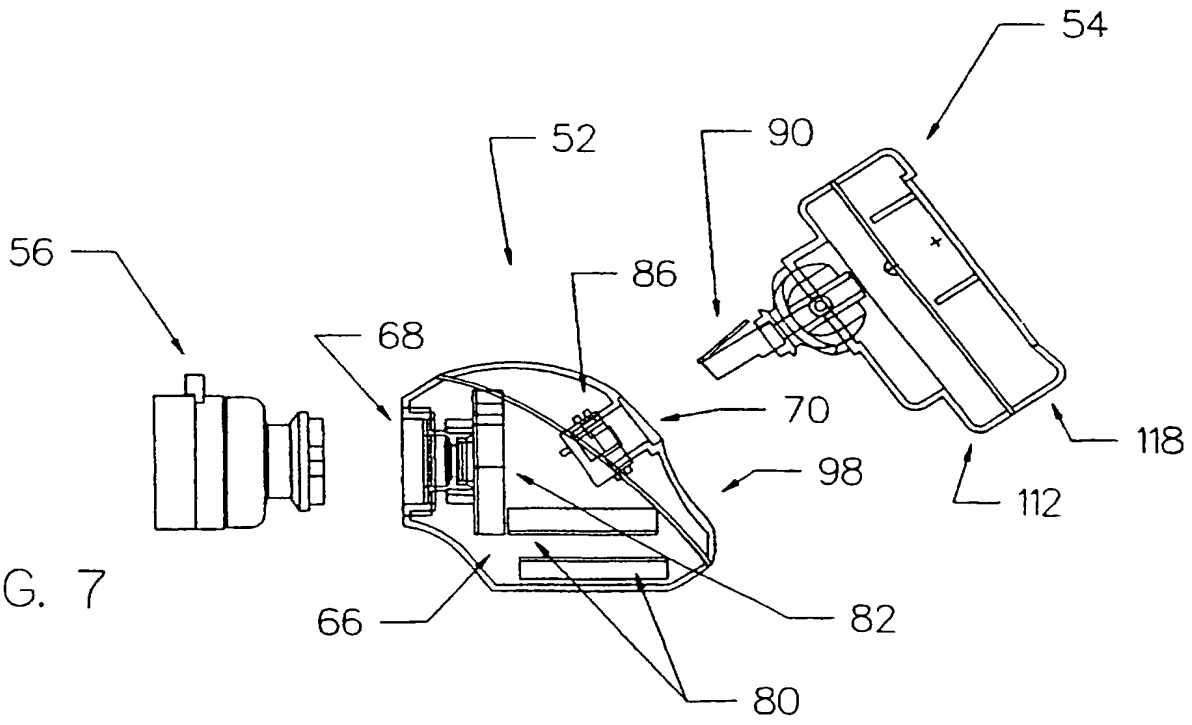

FIG. 7

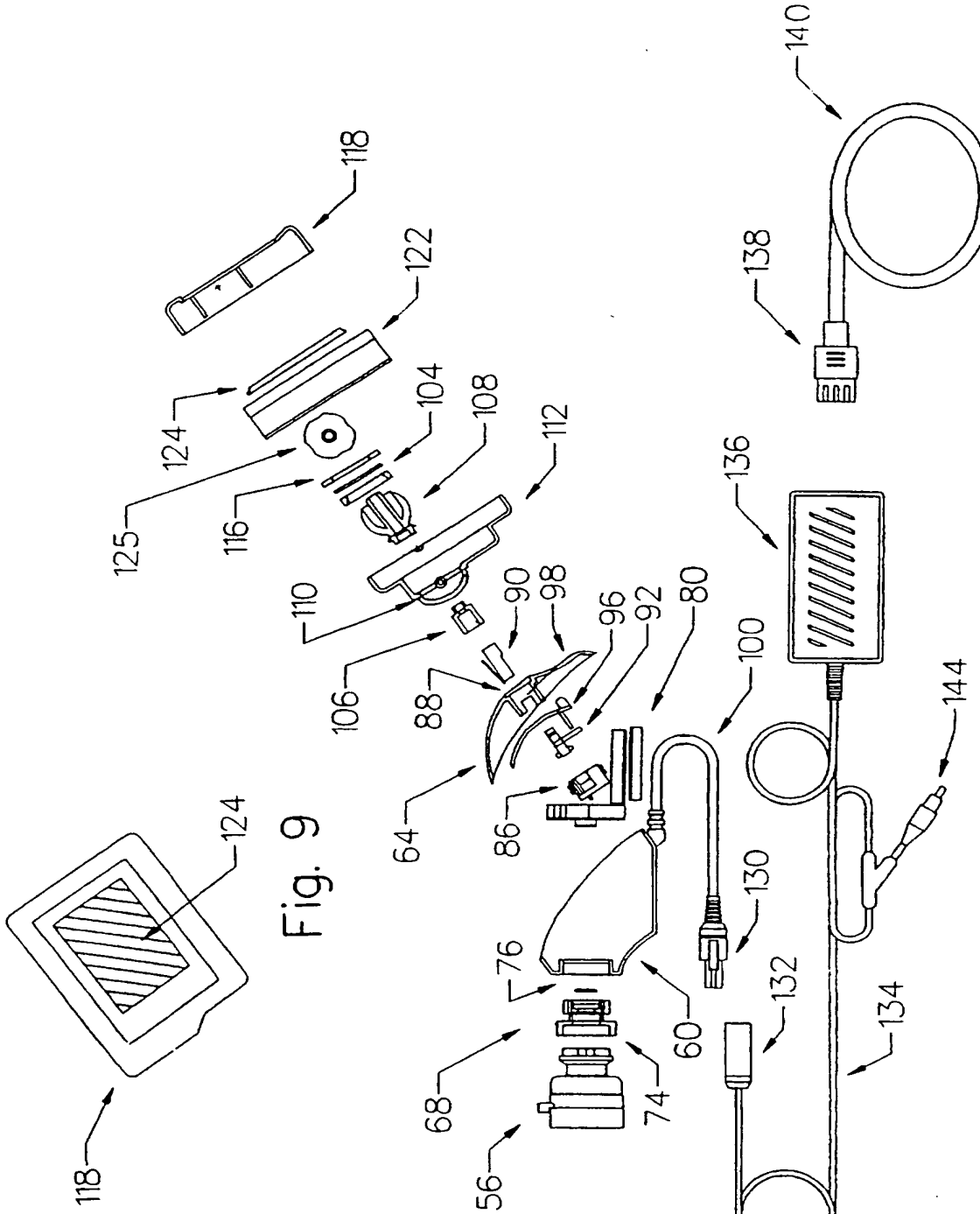

Fig. 9

Fig. 8

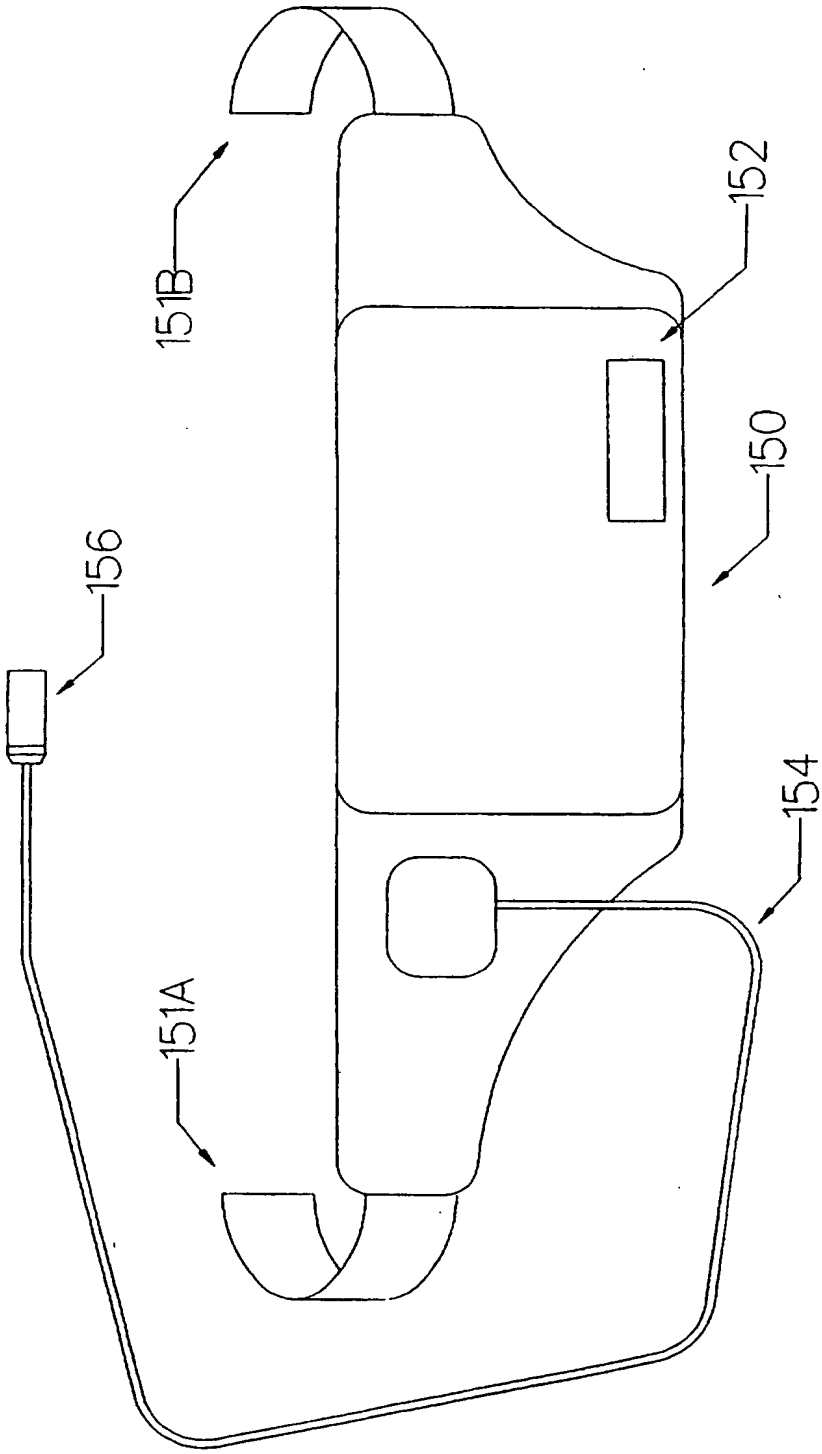

Fig. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/16594

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04N 7/18

US CL :348/65, 75; 600/101, 109

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 348/65, 71, 72, 75; 600/101, 109

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 4,926,258 (SASAKI ET AL) 15 MAY 1990, COLS. 3-6, 15.	1-12
A	US, A, 5,270,810 (NISHIMURA) 14 DECEMBER 1993.	1-12
A	US, A, 5,142,359 (YAMAMORI) 25 AUGUST 1992.	1-12
A	US, A, 4,253,447 (MOORE ET AL) 03 MARCH 1981.	1-12

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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